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ABSTRACT

The 8-chapter booklet gives an overview of what is known and what remains to be known about developmental dyslexia. Chapter 1 defines the scope of reading problems in general, while chapter 2 defines dyslexia-"children who have difficulty learning to read, for no apparent reason". Chapter 4 outlines the normal reading process. Possible causes for dyslexia, including educational, biological, and psychological factors, are discussed in chapter 5. Developmental, corrective, and remedial teaching methods are explained in chapter 6. Chapters 7 and 8 deal with prognosis and needed research respectively. (PHR)

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Developmental Dyslexia and Related Reading Disorders

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Foreword

The National Institute of Child Health and Human Development (NICHD) is dedicated to the principle that the early phases of the life cycle offer exceptional opportunities for preventing disorders which may affect individuals at any time in their lives.

One such condition which may have its roots early in life but shows up during the school years and through adulthood is the reading disorder, developmental dyslexia. The NICHD supports basic research aimed at improving diagnosis and therapy for children who suffer from this learning disability, which affects millions of Americans. Through fundamental research, we hope to gain a better understanding of the normal reading process and identify factors which prevent otherwise normal children from learning to read. This knowledge may help us detect and prevent dyslexia before problems develop.

This booklet is an overview of what is known and what remains to be learned about dyslexia. It is written for people who have some background in the fields of reading and reading disorders, and who work with reading-impaired children. Such people include learning disability specialists, elementary school reading teachers, and guidance counselors. Parents, pediatricians, and others who have a special interest in reading disorders may also find it informative to read this review of current knowledge about dyslexia.

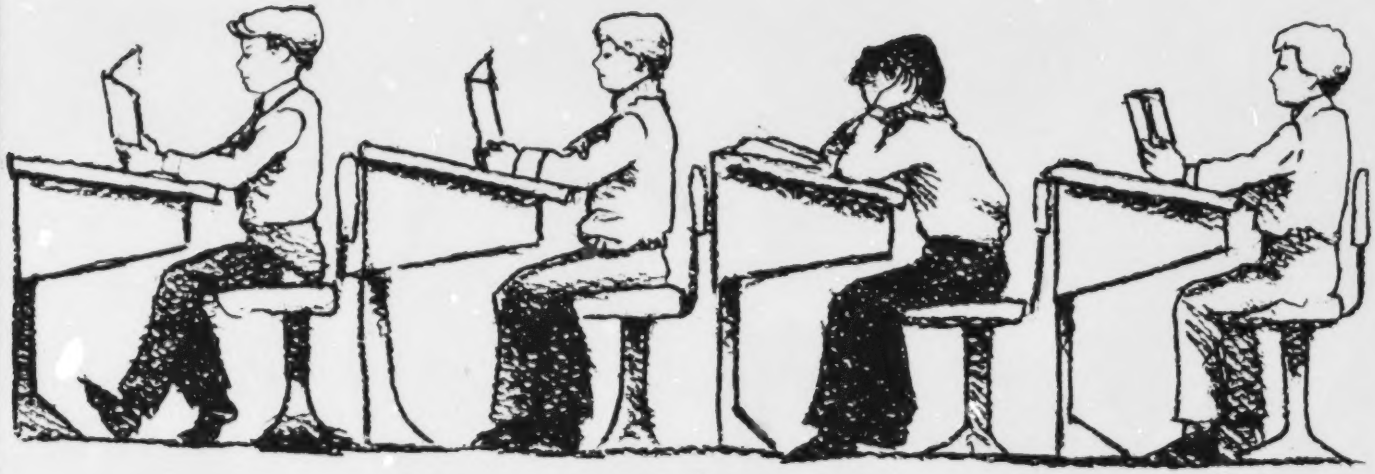
Norman Kretchmer, M.D., Ph.D.

Scope of Reading Problems

In advanced societies, the ability to read is the single most important foundation on which future learning is based. Without this ability, which most Americans take for granted, an individual is handicapped in many ways. Success in school depends upon it. So does obtaining and keeping a good job. Not being able to read, or read well, can deprive an individual of the advantages that are common to most Americans.

Yet despite the importance of the ability to read and our nation's commitment to an adequate education for all, reading problems plague our educational system to a degree that is alarming. It has been estimated that one out of every four students nationwide has significant reading problems; as many as half of the students in some school systems read below expectations for their age. And the phenomenon knows no boundary—it affects people at all levels of society, white and black, rich and poor, male and female.

The educational cost of requiring children to repeat a grade due to a reading problem reaches nearly $2 billion a year. But more important than the dollar cost to the school system is the cost to the nation, and to the children themselves, of allowing students who cannot read to leave school and enter society without the basic skill they need to function in society. It is here that the statistics are truly alarming: about half of the nation's unemployed youths age



16-21 are functionally illiterate, with virtually no prospects of obtaining good jobs. A recent study in a major Eastern city showed that 75% of juvenile offenders are two or more years behind in reading; other studies show a similar proportion of poor readers among adults convicted of criminal offenses.

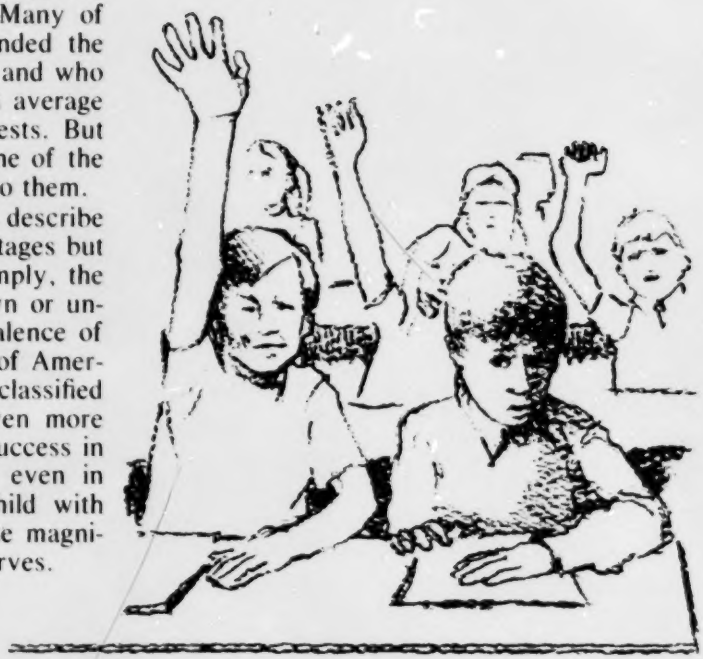
These statistics don't mean that today's schoolchild who cannot learn to read will become tomorrow's criminal, but they do point out the seriousness of the situation. Without the ability to read, most individuals are just not prepared to compete successfully in a complex society. Years of poor scholastic achievement—always a consequence of reading problems—lessen or eliminate opportunities in later life. At the very least, reading problems form a substantial roadblock to the attainment of real potential.

For many schoolchildren who struggle with reading problems, the cause of the problem can be identified and an effective remedial course designed. Many known causes of reading problems have been identified by researchers and educators, and effective programs designed to counteract the problems. Some of the more widely accepted causes of reading problems are vision and hearing impairments, poor speech and language development, poor general health, immaturity, a lag in readiness to learn to read, emotional maladjustment, poor home environment, and even poor

teaching methods.

But there are still many schoolchildren who have a serious reading problem for no apparent reason. Many of these children come from good homes, have attended the best schools, have parents who speak the language and who read and encourage their child to read, and test as average or above average in intelligence on standardized tests. But they still can't seem to learn how to read, and none of the known causes of reading problems seems to apply to them.

The term developmental dyslexia is used to describe these children who have all of the supposed advantages but still can't learn to read. The term means, quite simply, the inability to learn to read because of some unknown or undetermined cause. Although estimates of the prevalence of dyslexia are hard to obtain, as many as 15 percent of American students—about 1,200,000 children—may be classified as dyslexic, according to reliable studies. But even more disheartening is the fact that there has been little success in completely uncovering the cause of dyslexia, or even in creating remedial programs to ensure that the child with dyslexia learns to read. It is a problem of immense magnitude that is only now receiving the attention it deserves.



Defining Dyslexia

One of the basic problems associated with dyslexia is use of the term. Early researchers investigating the disorder began to use "dyslexia," "word blindness" and other words to describe many different conditions related to reading disorders. Some used the term very broadly, while others used a strict or narrow definition. Because of the confusion, many investigators even refused to acknowledge the existence of the term; they coined new phrases and used broader terms like "reading disorders" to refer to dyslexic conditions.

Progress in reading research suffered tremendously from this confusion. Vast amounts of data were collected which proved to be of little use in advancing the knowledge of dyslexia. Differing testing methods, experimental procedures, control groups, and research objectives were due in large part to different interpretations of dyslexia. And because the early research varied so greatly, much of it was incomparable; one piece of evidence could not be used as a stepping stone for further research.

As more knowledge accumulated, the term dyslexia began to take on a more specific definition. Today educators generally agree that there is a broad range of reading problems among schoolchildren for which specific causes have been identified. But there remains a smaller group of children who have difficulty in learning to read, for no apparent reason. These children are called dyslexic.

Another problem is the broad scope of the term dyslexia. Since it refers to all reading problems of an undetermined nature, it is unlikely that there is just one cause, and one type, of dyslexia. An examination of the symptoms of dyslexia shows errors in a wide range of skills, from identification of simple combinations of letters to comprehension and retention of material that has been read. As the causes of dyslexia are identified they will probably be eliminated from the category of dyslexia and termed specific reading disorders. In this way, the term dyslexia should become increasingly narrow in scope until there won't be a need for the term because all causes of reading disorders will have been identified.

But until we know the how and why of dyslexia, educators won't be sure that they are focusing their efforts in the right area, or that they aren't wasting their time on a theory that isn't valid.

The Normal Reading Process

Learning a complex skill like reading depends on attaining many component skills. The skilled reader reads so rapidly and smoothly that it is difficult to differentiate the components of the process. The skill is influenced by knowledge of the language, intelligence, home background, emotional stability, quality of education at school, and motivation. Slight deficiencies in any of these areas interfere with normal reading ability. In fact, considering all the variables involveo, many researchers are surprised that reading problems aren't more common than they are.

Experts agree that the essential skill in reading is extracting the meaning from a printed or written message, much like extracting the meaning from a spoken message. To read, an individual must recognize both the symbols and the meaning they represent.

But there are two schools of thought on just how this is done. One school holds that children must first recognize letters and words and then comprehend the meaning these letters and words represent. The second school believes there is an intermediate step after recognition, when the child transforms the written letters and words into spoken words and then comprehends the meaning. For the advocates of this second theory of reading, the intermediate step is very important.

Some basic skills involved in learning to read English are:

- knowledge of the language
- ability to recognize and discriminate between letters
- ability to adhere to the left-right orientation of words and sentences
- ability to recognize the printed word—the total word, the letters contained in the word, and the sounds represented by the letters
- knowledge of orthographic rules—that is, the rules that govern the sound-symbol correspondence of letters and words
- recognition that written words are representations of spoken words
- ability to reason and to think about what is read.

A child who can respond to printed letters mechanically without comprehending what has been scanned has not mastered what reading is all about. Reading is more than just identifying words and pronouncing them correctly. A few young children have amazed reading experts with their ability to flawlessly read aloud passages containing complex words they may never have seen before. But these children, called hyperlexics, have no idea of the meaning of

the words they are reading. They can recognize them and pronounce them, but they don't understand them. Although they can decode print at a very advanced level for their age, they have not mastered the skills involved in comprehension—the ultimate aim in reading.

Another important factor in reading is memory. When listening or reading, individuals usually remember the essence of what was said or written, but not the exact sentence word for word. Typically, individuals can, on demand, repeat verbatim the last few words spoken or read, but the earlier message has already been absorbed and is reissued in paraphrase. Thus a child who can decode words and sentences but can't remember what was decoded will have great difficulty reading.

Symptoms of Dyslexia

Children who have trouble learning to read show a great diversity of symptoms due to the complexity of the reading process. Even children with dyslexia show marked differences among themselves. Their only uniform characteristic is a reading level significantly below what one would expect for their age and intellectual level.

This lag in reading ability has usually been expressed as a delay in time, such as a two-year delay. For example, a fourth grader is said to read at a second grade level. While this method of measurement has been convenient, it is misleading: a two-year lag in reading ability for a third grader is much more severe than a two-year lag for a tenth grader, because the delay shows that the third grader learned few of the skills involved in reading while the tenth grader mastered eight years or 80% of the skills a tenth grader needs. So with each grade advancement, the same two-year delay becomes proportionately less severe.

Surveys that apply the same time delay to children of different developmental levels only confuse our understanding of dyslexia. For example, surveys have shown that only 3% of third graders are delayed in reading by two or more years, while 25% of ninth graders are delayed by the same two or more years. But the two-year delay in younger children is much more severe than in older children, so a comparison between the delay of third graders and ninth graders

based on an arbitrary figure is really not a true comparison.

Some researchers have proposed using a ratio, such as reading age divided by mental age, to assess reading ability. The use of such a ratio would be more accurate and helpful in comparing the reading delay of children at different stages of development.

Because advanced reading abilities are based on the acquisition of more elementary abilities, dyslexic children are likely to exhibit different symptoms at various stages of development. For example, the younger dyslexic, who is just beginning to learn to read, usually has trouble recognizing or decoding words and simple phrases. The older child may have mastered this level of development, but finds it hard to comprehend or remember what was read. An older child retarded at a more elementary level can still have difficulty decoding words as well as understanding what is read.

Samuel T. Orton, M.D., one of the first major researchers in the area of dyslexia, identified the dyslexic errors which are most widely known today. These errors include reversals in reading (b for d and tar for rat) and the omission or addition of entire words. Orton also studied the unusually high number of dyslexics who were left handed or ambidextrous, or had trouble differentiating between right and left. This research formed the basis of the theory that a neurological dysfunction might be a cause of dyslexia.

Today most investigators agree that only difficulty in right-left orientation is significant. Many studies have shown that right-handed children are not free from dyslexia and that many left-handed children are nomal readers. But difficulty in distinguishing between left and right still intrigues many researchers, perhaps because of the left to right orientation involved in reading English.

Another common symptom is faulty reading of vowels and consonants. Dyslexics misread vowels more often that consonants, and consonants that appear at the end of a word more often than consonants at the beginning of a word.

Other symptoms are a slow (word-by-word) reading rate and poor comprehension and retention of read material.

Some researchers have categorized these errors into two groups: *auditory* problems are difficulties in understanding the sound value of letters and their combinations (confusion of vowel sounds and substitution of one consonant for another); *visual* problems are errors of reversal and poor visual discrimination between words of similar shape.

Additional symptoms, which don't necessarily relate to dyslexia, have been identified in dyslexic children. Some of these are: (1) impaired directional sense, particularly right-left discrimination, (2) poor form (shape) discrimination, (3) poor discrimination of speech sounds, (4) faulty

conceptual or abstract thinking, (5) difference in handedness and eye preference (for example, a dominant right eye with a left-hand preference), and (6) general nervous system problems, manifested by awkwardness and other motor disorders. Experts do not know if these characteristics are related to dyslexia through direct cause or indirect cause, or are merely incidental to it. But a thorough investigation of these abnormalities, and a conscientious attempt to keep track of them in other research efforts, could help unravel the mystery of dyslexia.

The importance of well-developed speech and language abilities in learning to read has been emphasized repeatedly by researchers and educators. In fact, toddlers handicapped by delayed language have been predicted with amazing accuracy to encounter reading problems later on. Parents and teachers should, therefore, encourage speech and language acquisition in young children.

One of the most significant aspects of dyslexia is that it affects from three to six times more boys than girls. This disparity has encouraged the efforts of researchers who believe that dyslexia may be passed from parent to child much like hair and eye color. Additional support for this belief comes from studies of parents and siblings of dyslexic children, which have found a remarkable family history of reading disorders.

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Possible Causes of Dyslexia

When researchers, clinicians and reading authorities first began searching for the cause of dyslexia, they looked for one factor as the exclusive source of the problem. Now most experts agree that a number of factors probably work in combination to produce the disorder, although some researchers still emphasize one factor as the primary cause.

Although impressive evidence has been amassed relating dyslexia to specific theories, behaviors, and neurologic characteristics, dyslexia remains a mystery. Only after much more experimentation and research will the dyslexic puzzle be solved.

Possible causes of dyslexia may be grouped into three broad categories: educational, psychological and biological.

Educational Causes

Inadequate teaching methods

A child's primary task in learning to read is to link words as he or she knows them (spoken words) with mysterious graphic symbols. A large group of experts believes that the source of dyslexia lies in the methods used to teach children how to translate printed words into recognizable sounds.

Methods of teaching reading are numerous and varied. They change from year to year based on popular theories which may be unsubstantiated by hard evidence.

One of the more widely used techniques is the whole-word approach, or the see-say method. Using this approach, children learn to view words as whole units, as complete symbolic representations, rather than as groups of individual letters with corresponding sounds (phonemes).

A second teaching method popular in recent years is the phonetic approach: children learn about letters, their sounds and their order even before they learn about whole words. The child who learns to read through this approach has the crucial skills which enable him to learn new words and to benefit from the unique properties of an alphabetic writing system—to recognize words never seen in print, and to construct written words from their pronunciation. These skills are not possible with languages composed of different characters for each word, such as Chinese. Children who are unaware of the phonetic structure of English have greater difficulty in spelling, pronouncing and comprehending written words.

Many reading authorities contend that the best way to teach reading is to use a blend of the whole-word and phonetic approaches: while children memorize increasingly greater number of words by their shapes, they also learn the

phonetic rules necessary for decoding new, unfamiliar words.

Either approach can present its own problems. Many reading authorities say that the child who learns to read only by recognizing the visual shapes of words may memorize enough shapes to deceive parents and teachers into thinking that the early stages of reading are being mastered. Eventually, though, the child will become stranded at an elementary reading level and, worse yet, will lack the skills necessary to acquire new words.

These skills are supplied through the phonetic approach. But phonetic reasoning is primarily used in the more advanced stages of learning to read. At a very young age, it is easier to memorize the shape of the word "dog" than to go through the more intellectual process of stringing together its three component phonemes, "da," "aw," and "ga." Consequently, children susceptible to the pitfalls of the phonetic approach may get stuck in a sounding-out stage. They can sound out the "da" and "aw" and "ga" phonemes, but cannot combine them into the word "dog."

Difficulties in whole-word recognition can lead to omission of unfamiliar words (A HOUSE for A PICTURESQUE HOUSE), addition of words (ONCE UPON A TIME I WAS for ONCE I WAS), substitution of words with nearly equivalent meaning (WENT for DROVE), or similar behaviors. In these instances, the child is trying to

guess based on the context in which the words are used. Whole-word recognition failure frequently occurs around the fourth grade.

Fortunately, most children overcome any obstacles posed by teaching methods, and learn to read at a normal rate. But other children have undetected reading problems that make them particularly vulnerable to the drawbacks of certain approaches. Experts who support an educational cause for dyslexia say that improving the beginning reading program would go a long way toward eliminating reading problems.

Difficulties of English orthography

Some investigators suggest that the complexities of English orthography—representation of the sounds of English by written letters—make it impossible for children who have not mastered letter-phoneme associations to learn to read. Studies of children who don't understand letter-phoneme correspondences indicate that although they have trouble matching a group of written words to a single spoken word, the first letter of the written words they select is usually the first letter of the spoken word. For example, if the spoken word is "paper," children usually demonstrate a sufficient grasp of phonemes to select written words beginning with "p," such as "pen" or "pretty," over written words beginning with other consonants. Successful place-

paper

pen

pretty

ment of consonants other than those beginning the word depends on their position within the syllable; identification of consonants at the end of the word produces about twice as many errors as identification of consonants beginning the word.

Identification of vowels, on the other hand, produces a greater number of errors regardless of the vowel's position within the syllable. One widely accepted explanation for this occurrence is the extreme variability of English vowel orthography: whereas consonants have a rather consistent letter-phoneme relationship, one vowel can represent many different sounds depending on how it is used and the words in which it appears.

Dyslexia is said to be less prevalent in countries such as Spain, where the alphabet follows consistent letter-phoneme relationships than in Sweden and North America, where letter-phoneme relationships are not as consistent. However, this apparent difference may be the result of inaccurate records, noncomparable test groups and procedures, or differing definitions of dyslexia.

Undoubtedly, the inconsistencies of English sounds and word spellings make the language hard to learn to read, especially for the dyslexic child. But variations in English orthography cannot fully account for the prevalence of dyslexia in this country.

Inaccurate intelligence tests

Dyslexia is a reading disability in a child of normal intelligence. This definition presupposes the ability to accurately measure intelligence, which is the function of tests of intelligence (I.Q. tests).

Care must be taken when interpreting I.Q. tests because the results can be influenced by factors other than intelligence. Many tests, especially written tests, require considerable verbal skills to complete, and are therefore unsuitable for the poor reader. But even if a test requires only minimal verbal abilities, dyslexic readers may take the exam reluctantly and therefore do poorly. Dyslexic children frequently become accustomed to failure and do not care how they do on any written exam. This defeatist attitude is especially apparent in older dyslexic children. After years of frustration, they have more than just a reading disability—they have a strong aversion to books and the reading process.

Some educators assert that poor reading test scores among so-called dyslexic children are due to faulty, inadequate tests rather than to problems of the children. Reading tests must be at fault, they say, if the tests indicate that children of known normal intelligence read at a subnormal level. These people, however, lack convincing evidence to support their view of dyslexia as a nonexistent condition.

For example, they cannot pinpoint those aspects of reading or intelligence exams which cause only a few "normal" children so much trouble.

Other researchers believe that all dyslexic conditions are the result of low intelligence, regardless of what intelligence tests may reveal. Certainly, dyslexia may contribute to reading problems in children of below normal intelligence. But present evaluation procedures and scientific knowledge make differentiating dyslexia from low intelligence extremely difficult and inaccurate. Dyslexia is conspicuous in the bright child; it often remains hidden in the child of below normal intelligence.

Among other factors which can influence the outcome of intelligence examinations are malnutrition, the child's cultural environment, prior educational experience, familiarity with intelligence exams, and even how the child feels at the time of the test.

Psychological Disturbances

A second major school of thought among reading experts links dyslexia to psychological or emotional disturbances. Such disturbances can emerge from a number of situations: homes in which parents continually argue and discipline is inconsistent, the absence of a parent, frequent change of schools and poor relationships with teachers. If the child has a physical handicap or some distinctive physi-

cal feature, name-calling by peers can also inflict great emotional damage, leading to later reading problems.

Poor parent-child relationships, which can greatly retard a child's emotional development, may also adversely affect normal reading development. Parents who cannot accept a child's "imperfections" may reject the child or become too demanding. These demands sometimes take the form of well-intentioned parental prodding for a child to perform as well as a playmate or older sibling. Failure to meet parents' unrealistically high expectations may result in feelings of inferiority, submission or defeat.

Parents of undiagnosed dyslexic children can increase emotional stress through well-meaning attempts to shame their child into better achievement. Some parents angrily label the child stupid or lazy, thinking the accusations may spur the child on. Teachers can do the same thing by asking the child cruel questions like "Won't you ever learn?" Children with reading difficulties often have great feelings of frustration and failure, and may channel their feelings of helplessness into anger, hatred and violence.

Most reading authorities agree that emotional problems are the result rather than the cause of reading problems. But while emotional stress may not be the source of the dyslexic child's problem, an increase in that stress can aggravate the dyslexia.

Biological Causes

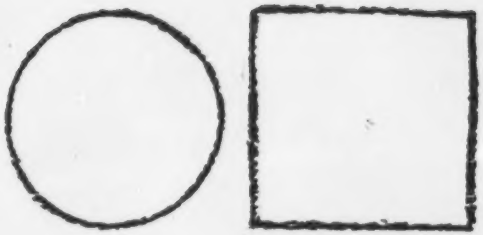
There is general agreement among reading experts that the source of dyslexia probably stems from the child's own psychological/physiological make-up, rather than from environmental influences. But agreement stops here.

Individuals supporting a biological basis for dyslexia believe that the disorder may occur when the functions of the brain are organized abnormally, or when the language areas of the brain are not clearly lateralized (dominated by one of the brain's two sides). This group thinks the unusual, deviant behaviors often accompanying dyslexia are extremely important as indicators of brain dysfunction. Their primary concern in studying the brain is to determine which neurological remedial approaches will benefit the dyslexic child.

In opposition to neurologists are the educators and psychologists who maintain that the remedial focus should not be on the brain, but on the deviant behaviors dyslexic children exhibit. Science knows too little about the brain, they say, for neurologic research to discover the answer to dyslexia in the near future.

Some of the more prominent deviant behaviors which neurologists consider indicators of brain impairment are:

Visuoperceptive deficit—Vision is a complex sense that depends on several processes. On one level, vision



requires that individuals sense what is before their eyes. Problems in visual acuity and fusion, limited eye movement, abnormal eyeball configuration, and other visuosensory difficulties can decrease clarity and sharpness of vision. A small number of researchers believe such vision problems are the main cause of dyslexia; some optometrists in particular attribute dyslexia to abnormal eyeball shape. However, most reading experts agree that basic visual difficulties and impaired control over eye movements are not enough to account for the problems of the dyslexic child. Studies have indicated that degree of control over eye movement is not a critical factor in learning to read; only minimal control is required.

At another level, vision requires the accurate interpretation of what is visually sensed. A child with higher-level visual problems, often called visuoperceptive deficits, has trouble distinguishing one visual form from another—a circle from a square, or "a" from "e," for example. Research has been largely inconsistent in pinpointing a visuoperceptive skill deficit in reading disabled children; even the results which indicate this deficit exists have shown only a small percentage of dyslexics to be deficient in visuoperceptive skills.

Some researchers, supported by valid evidence, theorize that the reading disabled children most frequently lacking in higher-level visual skills are children (ages 5-8) who

are beginning to learn to read. Visuoperceptive deficits, however, are not the characteristic behaviors differentiating older dyslexic children (ages 9-12) from their normal reading peers, according to the same evidence. The older dyslexics show their most marked difficulties in skills associated with language use and abstract concept formation. Several explanations have been suggested for this difference. Some experts believe that even though visuoperceptive handicapped children have the capability to read, they must go through a period of adjustment to their handicaps during initial reading instruction. As a preventive measure, some schools systematically teach higher-level visual perceptive skills in the first grades. Other experts see reading as a word-by-word process in younger children, whereas older children rely more on context, meaning, scanning for chunks of information, and other advanced conceptual skills.

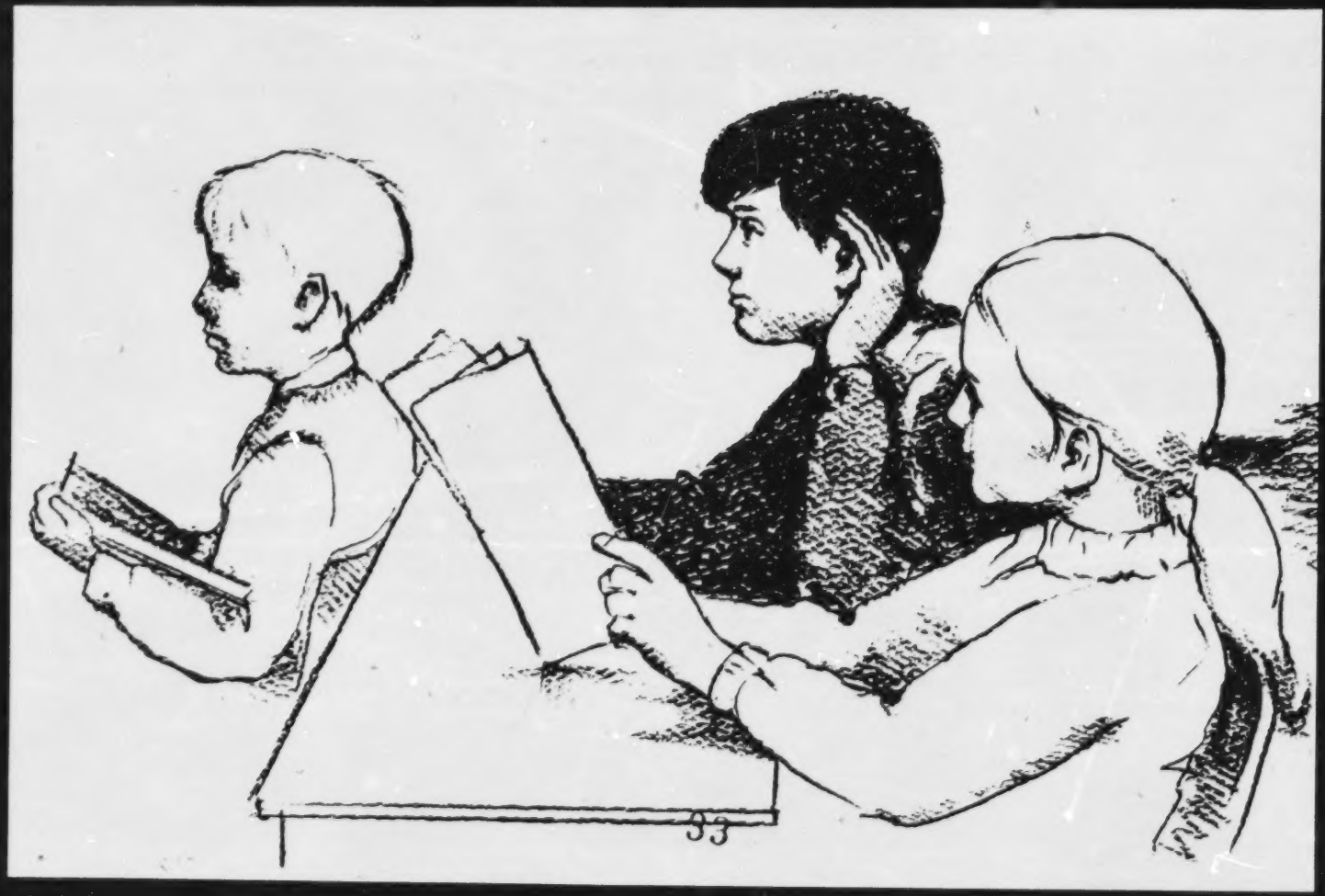
While deficient visuoperceptive skills may be responsible for reading failure in younger years, their effects are believed to be transient and cannot account for the massive failings of older dyslexic children.

Retarded language development—Retarded oral language development has frequently been suggested as a significant contributor to dyslexia. Poor readers often have a very limited vocabulary and use an even smaller part of that vocabulary in everyday speech. Their grammatical constructions are linguistically immature. Children with retarded oral

language development can usually function adequately in normal speaking situations, but they are easily confused by uncommon usages of the language. The rhyming patterns of poetry present difficulties, for example: many times the children understand the meaning of poems, but they cannot easily replace a word with another rhyming word. Their limited language abilities do not permit them to play with language or the sounds of language. Thus, these children may have trouble segmenting and rearranging language sounds when they attempt to speak in pig latin.

Conversely, general language disability, especially among older children, might be the result of inadequate reading abilities. The child who cannot read properly could be expected to acquire vocabulary, general information and mature grammatical constructions at a slow rate. The most widely held interpretation, however, says dyslexia is the final, crippling manifestation of an overall language disability. Most of the evidence supports this conclusion.

Additional support for a language-based origin of dyslexia comes from studies in which verbal and nonverbal stimuli were presented to groups of normal and reading impaired children. In one study, good and poor readers were shown several cards one at a time. Printed on each card was either a verbal stimulus (nonsense syllable) or a nonverbal stimulus (nonsense design or photographed face). Four of the stimuli kept reappearing, but otherwise the stimuli were different. The children's task was to tell if they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had already seen each stimulus as it was presented. The result: normal and impaired readers showed no significant difference in ability to recall photographed faces or nonsense designs. However, the normal readers were far better at recalling the recurrence of the nonsense syllables. It appears that the normal readers' language ability permitted them to process the verbal information more efficiently.

Impaired intersensory integration—Reading and other language abilities rely heavily on the ability to hear. People who are deaf or severely hearing-impaired from birth find reading and writing extremely difficult because they have never been able to associate written words with the auditory counterparts. Similar problems may occur in a hearing person if the brain is unable to integrate what it hears with what it reads. Researchers have, in fact, determined that many dyslexic children are unable to associate auditory and visual stimuli, especially at the linguistic level.

This does not mean that reading always relies on phonetic representation. Advanced readers may bypass the phonetic stage and translate meaning directly from print. But at the reading acquisition level, the evidence clearly indicates a need for the printed word to be associated with the spoken word.

Normal and advanced readers may also phonetically recode the printed words to increase comprehension, even when they are reading familiar material. This is especially

true when readers must remember what they have read; researchers have noted that even nonlinguistic stimuli are remembered more by their names than by their functions or associations. So it is not surprising that mistakes in recall are most likely to be based on phonetic confusion (jar-char) rather than visual similarities (jar-jam) or functions (jar-can).

Some evidence even suggests that vision may depend on auditory stimulation for maximum development. People who are deaf from birth apparently do not see as well as normal-hearing people, and persons with acquired deafness have better sight than those deaf from birth, although still less developed than in normal-hearing persons.

Impaired memory—Since most researchers evaluating intersensory integration have presented stimuli consecutively rather than simultaneously, the failures they report could be due in part to short-term memory disorders.

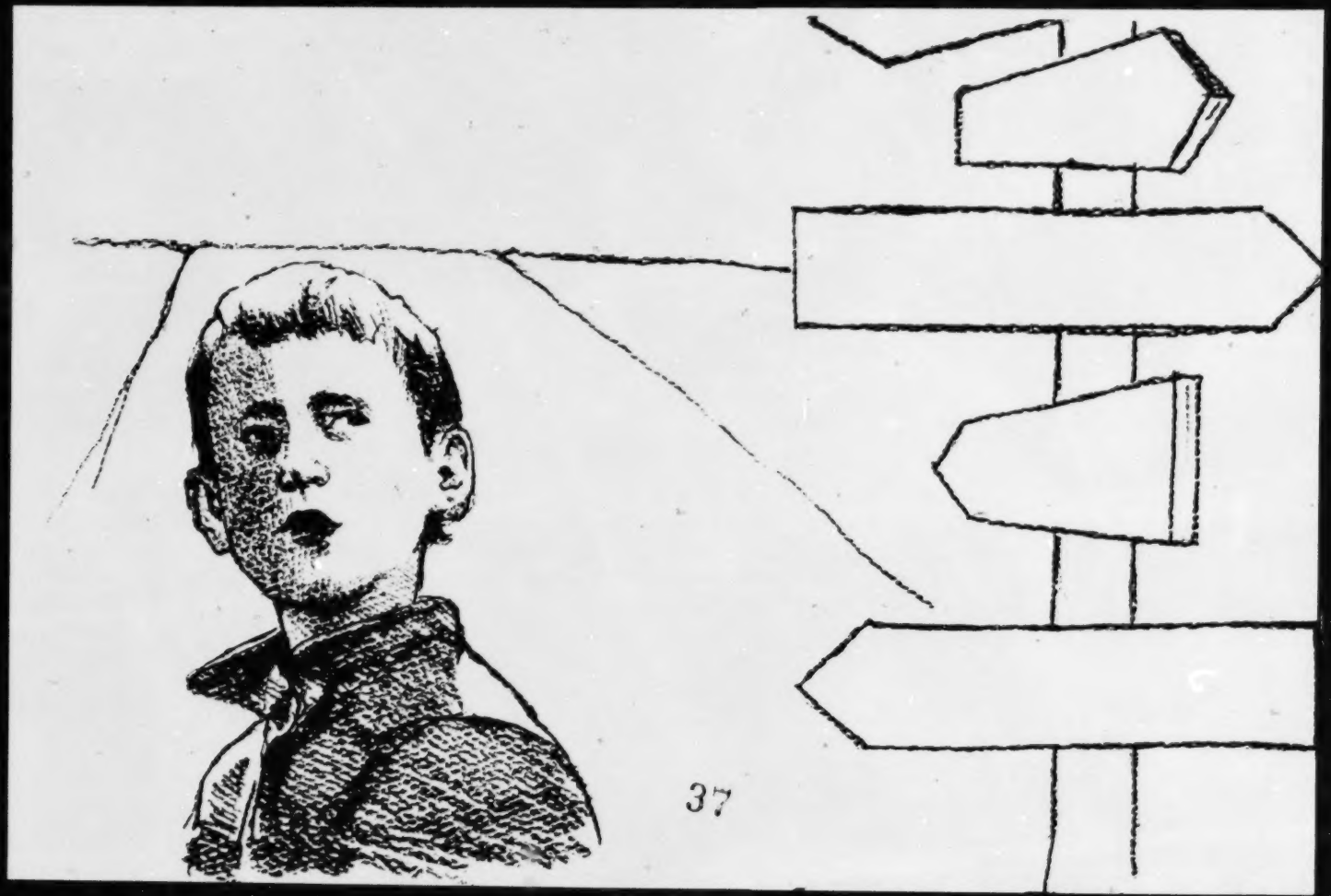
During dialogue, listeners hold small pieces of information (syllables and words) in short-term memory until enough information is amassed to complete whole thoughts (sentences). The duration of this short-term memory can be demonstrated by interrupting someone who is listening to a person speaking. The listener can usually repeat the last few words exactly as the speaker said them, but typically paraphrases the earlier spoken communication. The earlier words are transformed into a linguistically complete concept.

If reading parallels speech perception as an expression of general language abilities, then reading probably makes use of short-term memory. A disorder in this memory system at the phonetic level would leave the child unable to remember what has just been read.

Sequential perception deficit—Another disorder considered by some to be the primary cause of dyslexia is manifested by confusion in perceiving and remembering the sequence of sensory input. A child whose basic problem is in *visual* sequential perception might view the sentence "I saw the dog run" as "was I run the gdo," where both words and letters within words are in the wrong order. A child with faulty *auditory* sequential perception may confuse the order in which words are heard, and so may not develop the general linguistic abilities many experts believe essential for normal reading acquisition.

In their studies of sequential perception, researchers have found that subnormal readers have trouble identifying digit and figure sequences. This failure appears to be even more pronounced when the sequences are presented in a mixture of auditory and visual forms. Other research has suggested that later reading abilities are more accurately predicted from sequence tests using both auditory and visual stimuli than from tests which employ only visual stimuli.

Impaired directional sense—In the early stages of reading acquisition, all children make mistakes in reading



and writing, particularly reversals (b for d) and rotations (p for d). Normal children quickly outgrow these developmental dysfluencies, but dyslexic children may continue to exhibit impaired directional sense for long periods of time. Some researchers believe a continuation of impaired directional sense beyond age nine or ten strongly indicates the possibility of dyslexia.

An impaired sense of direction seems limited only to manipulations of symbolic figures. Abilities in sports, where quick directional decisions are required, are normal in the dyslexic child. While experts concur that confused directional sense may contribute to reading difficulties in younger children, the impairment does not appear to be a primary source of dyslexia in older children.

Developmental lag

Differences in the ages at which dyslexic children express deviant behaviors have led some researchers to suspect that dyslexic children may have slower brain development than normal children. The dyslexic child's problem, they say, is a simple lag in brain maturation, not an impairment in brain functioning.

In normal children, developmental skills such as perception, directional sense and intersensory integration that are necessary to the acquisition of reading emerge at more or less fixed chronological ages. The early stages (ages 5-8)

of reading acquisition depend mainly on higher-level visual skills, whereas later reading advancement (ages 9-12) requires abilities in language use and abstract concept formation.

Supporters of the developmental lag theory believe dyslexic children develop the same skills as normal children, but at a much slower rate. Consequently, the types of difficulty dyslexic children show change as the children grow older. By age 6 normal children have mastered the higher-level visual skills necessary to succeed in beginning reading programs, but dyslexic children have not. The 6-year-olds do not seem to differ in language use because neither group has yet attained the linguistic skills necessary for reading. But by the time normal children develop these linguistic abilities, the dyslexic children, still lagging behind the normal group, show language-related difficulties. By this time the dyslexic children have caught up with normal children in mastering higher-level visual skills, and may now be failing advanced reading instruction just when they are ready to profit from teaching at the elementary level.

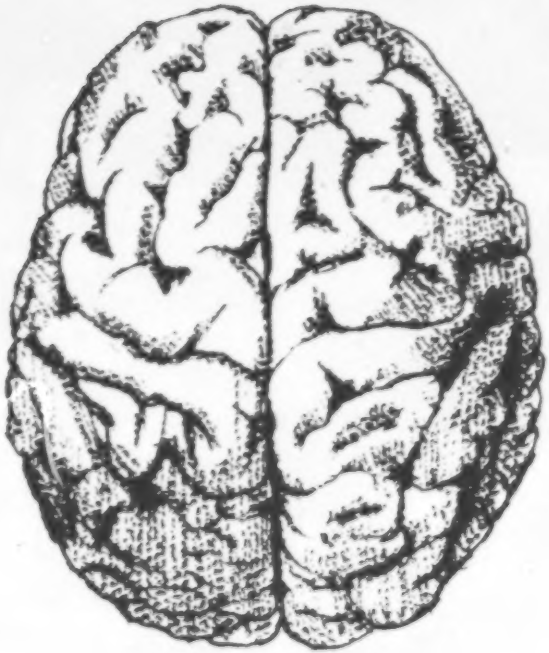
As dyslexic children grow, an increasingly longer period of time is required for them to master each new reading skill. One possible explanation is that perhaps dyslexic children simply stop improving their reading abilities as they grow up. Whatever the reason, older dyslexic chil-

dren lag much further behind their normal peers than they did when they were younger.

The developmental lag theory does not explain why some dyslexic children eventually catch up in reading ability with normal children, or why others never do. One possible explanation is that if the dyslexic child does not surmount his difficulties before puberty—the stage where maturation of the central nervous system is almost complete—the child may have a permanent reading handicap.

Neurological factors

Electrical and chemical activities in the brain are believed by some to be ultimately responsible for every human act, movement, thought and even emotion. Individuals who accept this premise may agree with investigators who assert that disturbances at some level of neurological functioning are the root cause of dyslexia. Most researchers can accept that there is a relationship between neurological dysfunctioning and dyslexia—but opinions differ dramatically on whether there is a need for extensive neurological research, where to focus this research, and which remedial approaches are most effective. In the group strongly supporting the neurologic interpretation of dyslexia and the importance of neurologic research, experts have developed various theories to explain the nature of brain damage in dyslexic children:



Cerebral dominance theory—One of the earliest and best known of the neurological theories concerns cerebral dominance: the ability of one portion of the brain to predominate in controlling certain behaviors.

The human brain is divided into left and right hemispheres, each having primary duties. In most people the right hemisphere is mainly responsible for nonverbal, perceptual abilities. Damage to the right brain can cause impaired judgment of tonal patterns and special directions, and poor recognition of geometric designs. The left hemisphere regulates verbal functions, including speech (in most people) and functions related to written language. Left brain dysfunction, therefore, could be expected to cause impaired speech, comprehension, or writing and reading abilities.

An interesting relationship exists between the hemispheres regulating language function and hand preference. The vast majority of people (about 93%) are right-handed, nearly all having language controlled by the left side of the brain. But only about 70% of left-handed people have language controlled by the left hemisphere; the others have language function in the right brain or divided among the two hemispheres.

The cerebral dominance theory maintains that the failure of a single hemisphere to dominate verbal functions—the perception of graphic symbols and the language functions associated with reading—results in dyslexia. Pro-

ponents of the theory believe that in the normal brain visual imprints made on the verbal dominant hemisphere are used to build associations between letters and spoken words. If for some reason the verbal controlling hemisphere fails to dominate verbal functions, the person also perceives the visual imprints simultaneously made upon the nonverbal hemisphere. These imprints, however, appear backward, as if viewed through a mirror. A child with poorly established cerebral dominance, so the theory goes, is unable to interpret written symbols, or interprets them in the reversed direction in which they are perceived (d for b, saw for was).

Since about 30% of left-handed persons have language located in the right or in both hemispheres, cerebral dominance research has sometimes identified these individuals as prime candidates for dyslexia. Tests for hemispheric dominance have been conducted by noting preferences in listening, clapping, jumping, sighting with one eye, and balancing on one foot. Failure to demonstrate a decided preference for one side or the other, the theory maintains, indicates a defect in brain development which is fully or partially responsible for dyslexia.

Solid evidence to support the cerebral dominance theory has been lacking. Most recent studies have not supported the concept that dyslexic children differ greatly from normal readers in right-hand or left-hand preferences.

Minimal brain dysfunction theory—Extensive research on the brains of non-human animals shows a direct, though not one-to-one, relationship between neurologic functioning, learning abilities and behavior. Experience with war-injured veterans confirms that this relationship also exists in human beings. The minimal brain dysfunction (MBD) theory transforms these observations into a theory that children with dyslexia must be suffering from some degree of brain dysfunction.

The concept of MBD is an assumption. Only neurological dysfunctions which are undetectable by present physiologic and biochemical procedures are referred to as MBD.

MBD is further defined as a dysfunction in a specific area of the brain. Studies of lower animals and veterans with localized brain damage show impairment in behaviors and learning skills governed by the particular areas of the brain which are damaged. The MBD theory simply turns this observation around: children demonstrating specific deviant behaviors and impaired learning abilities must have dysfunctions in areas of the brain controlling the activities, even if the dysfunctions are undetectable. The theoretic nature of minimal brain dysfunction has led some investigators to question its existence.

MBD is expressed by several characteristics which may occur in combination or alone: hyperactivity, slow and

awkward movement, short attention span, perceptual impairment, problems with memory and abstract thinking and concept formation, emotional instability, disordered speech and hearing, and specific learning disabilities. The MBD child's learning difficulties may show up as problems with language, reading, writing, and spelling. The abstract reasoning and good memory required for arithmetic frequently present a problem for the child with MBD.

While MBD presumably affects one or more areas of the brain, it does not substantially reduce overall intelligence, if it affects intelligence at all. The MBD child is usually of average or above average intelligence, with particular learning and behavioral symptoms ranging from slight to severe. A child of low intelligence can also have dyslexia resulting from MBD, but there are problems in determining the extent to which each of the conditions contributes to the reading disorder.

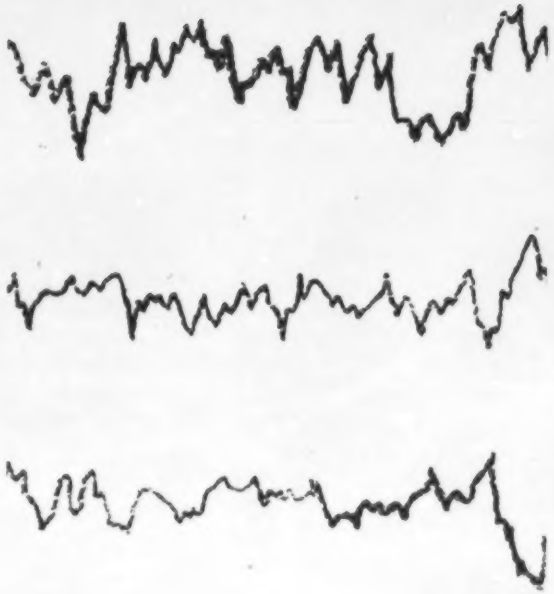
MBD is declining in popularity as a suspected primary cause of dyslexia.

By using the electroencephalogram (EEG), a device which records the electrical activity in the brain, neurologically oriented researchers are attempting to demonstrate a

neurological basis for dyslexia. Results from this method have been disappointing for the most part. There seems to be no direct relationship between the severity of dyslexia and the degree of EEG abnormality. Also, normal readers often show a great amount of "abnormal" brain activity. One hypothesis which may explain the poor EEG-dyslexia correlation suggests that EEG abnormalities in dyslexic children may result from the stress of frustrated attempts to read rather than from the physiology of the disorder.

Finger recognition is another test used by neurologically inclined researchers. In this test, the suspected dyslexic child interlocks his fingers and moves each one individually in response to a researcher's light tap. Poor readers seem to have more trouble responding than do their normal reading counterparts. Studies, however, have been inconclusive in determining whether finger recognition is a good indicator of dyslexia.

In summary, neither neurological theories nor a neurological basis for dyslexia has been firmly established. This same evidence, however, has maintained a strong interest in the neurologic orientation. Many experts believe scattered findings from EEG and finger recognition tests, and behavior correlates such as intersensory integration deficits, sequential perception difficulties and general linguistic disabilities, fit neatly into a neurological framework.



Complete medical evaluations of a large number of dyslexic children have failed to reveal consistent patterns which could be used to diagnose reading problems. However, there is reason to believe that unidentified neurologic disorders may be active in some cases of dyslexia, while other forms of dyslexia may not be associated with neurologic impairment at all.

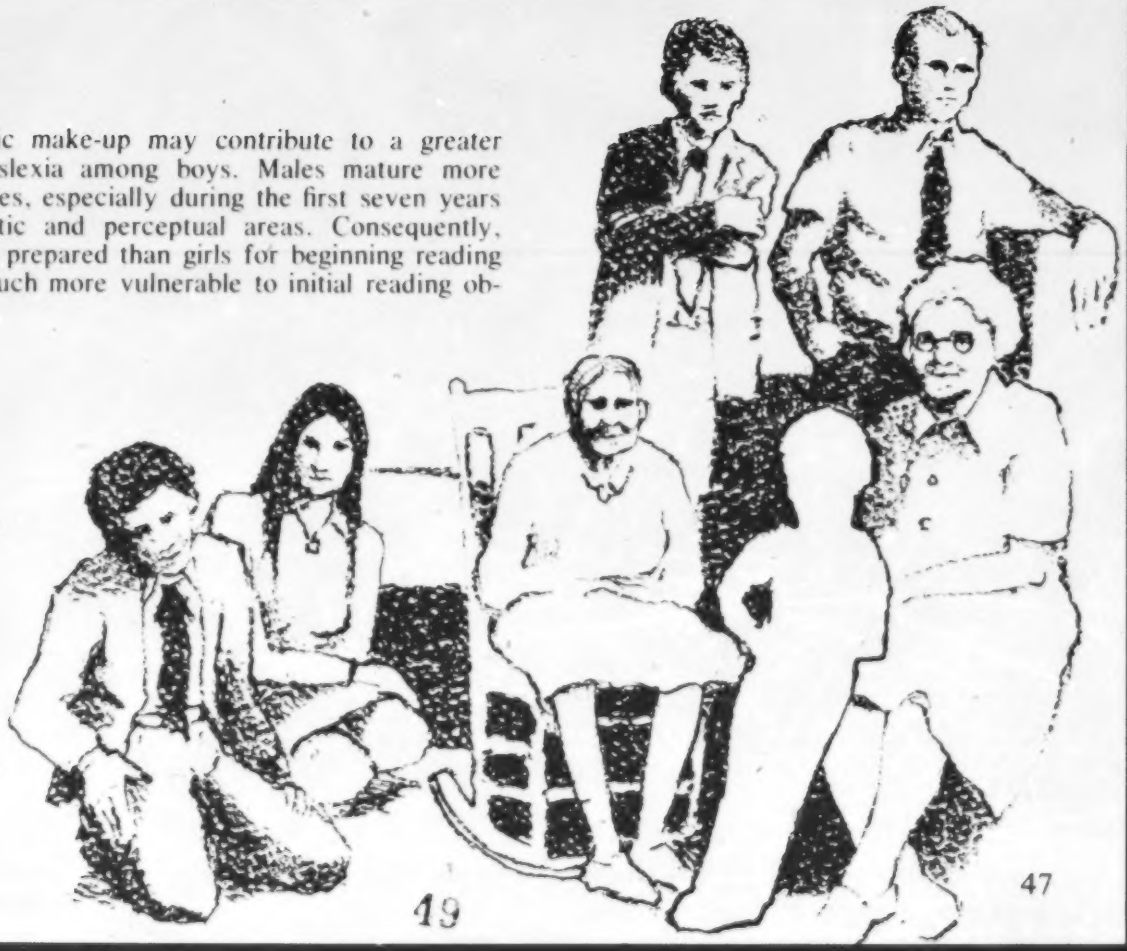
Genetic factors

Dyslexia seems to run in families: up to 40% of dyslexic children have family histories of the disorder. But data on the genetic aspects of dyslexia are sparse. Research has yet to determine how the disorder expresses itself in parents as contrasted to how it shows up in their children. It is possible that the same behaviors are passed from parent to child in some forms of dyslexia but not in others.

The nature of dyslexia's genetic link is hard to isolate because nongenetic influences such as family size, parental attitudes and familial interaction may figure in dyslexia. The interaction between genetic and social inheritances is of great importance to dyslexia research, but has not yet been adequately examined.

The fact that dyslexia affects from three to six times as many males as females suggests that genetics contributes significantly to the disorder. But factors other than a child's

unalterable genetic make-up may contribute to a greater prevalence of dyslexia among boys. Males mature more slowly than females, especially during the first seven years of life in linguistic and perceptual areas. Consequently, boys may be less prepared than girls for beginning reading instruction and much more vulnerable to initial reading obstacles.



Teaching Methods

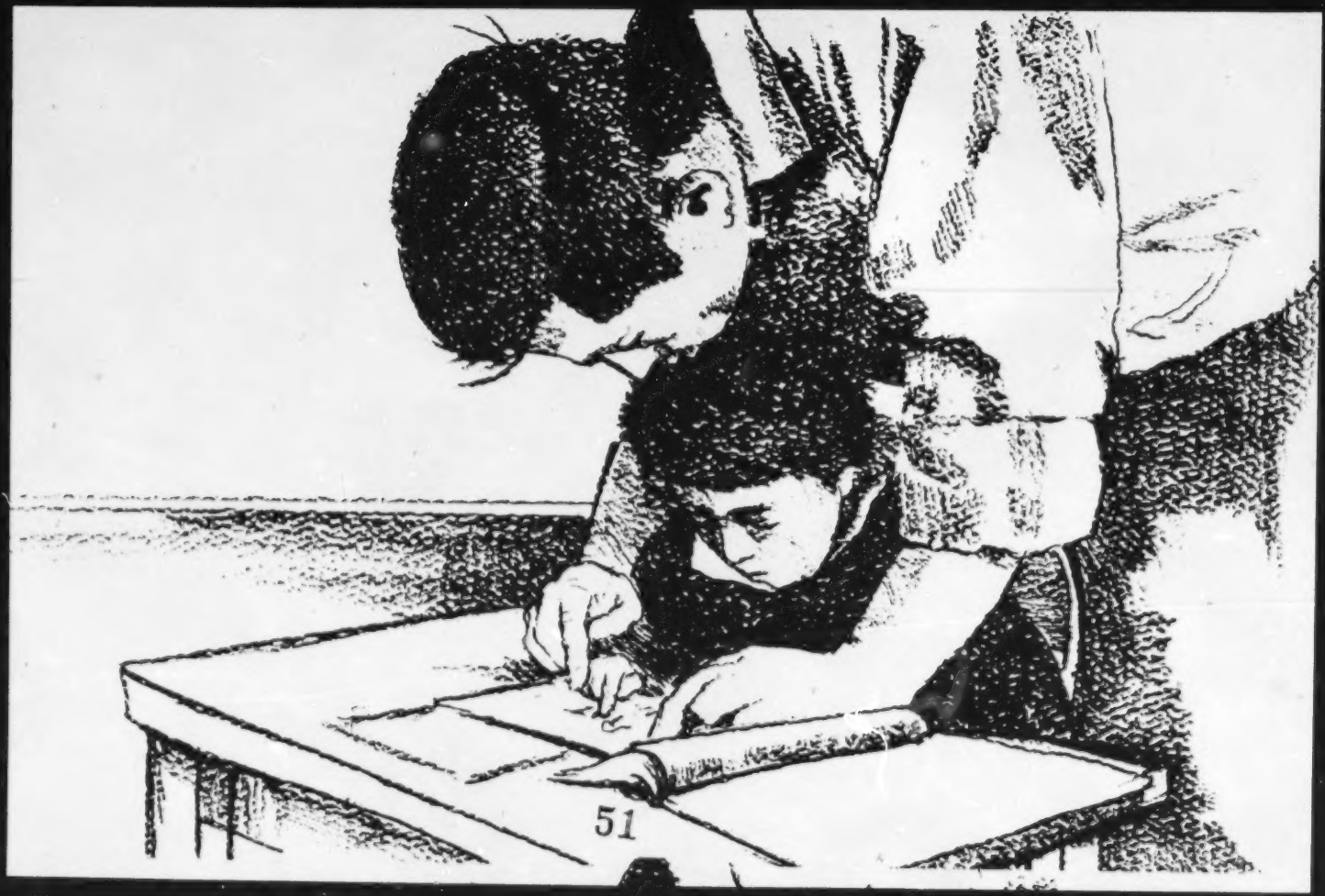
Just as children with dyslexia comprise a heterogeneous group, the teaching methods used to help them are similarly varied. Some methods seem very effective with particular groups of children, but are ineffective with others. Still other methods achieve mediocre results no matter what the characteristics of children enrolled in the program.

There is no proof that any one method will work for all children. Until we know which programs are the most effective, remediation should be designed to meet each child's needs. All remedial procedures will vary in effectiveness from child to child—but without an individualized program, it's always possible that a child who isn't making any progress is just floundering in the wrong remedial program.

A properly designed remedial program should consider all characteristics of the child. It should be based on the child's estimated capacity and behavioral symptoms, and the suspected causes of the problem. Program designs should include the methods and materials to be used, and the tasks in which the child is expected to become competent.

Most programs designed to help the dyslexic can be grouped into three categories: developmental, corrective, and remedial. Some programs may encompass aspects of more than one approach or perhaps all three.

The developmental approach has been described as a "more of the same" approach: teachers use the same basic



methods that were used in the regular classroom and proved ineffective at the time on the premise that the methods were sound and the child just needs extra attention. The increased attention is usually in the form of small group or tutorial sessions, where the teacher can work on reading with each child. Many researchers and educators find this approach to be of questionable value. They point out that if the original program was not effective, no amount of intensified instruction using the same method will be fruitful.

The corrective reading approach uses small groups of tutorial sessions like the developmental approach, but emphasizes the child's assets and interests. By emphasizing the positive and not the negative, researchers hope to encourage children to rely on their own abilities to overcome their difficulties.

The third approach, called remedial, was developed primarily because the first two systems were plagued with failure. Proponents of the remedial approach try to ameliorate the psychological problems which underlie poor reading. While the program may utilize a child's assets, it is directed mainly at the psychological deficiencies and tries to remedy the underlying factors contributing to the problem. Supporters of the system believe that it is essential to determine first which skills cause the most difficulty and then apply individualized techniques that will best remedy those deficits. Most current methods for teaching dyslexics use this remedial approach.

Prognosis

For dyslexic children, the prognosis is mixed at best. There is no easy answer. The disability affects too broad a range of children, with a great diversity of symptoms and degrees of severity, for anyone to offer a clear-cut prediction.

For far too long, parents of dyslexic children have encountered the standard explanations when no one could pinpoint the trouble. Statements like "the child will read when he is ready" or "she'll soon outgrow it" do not acknowledge the existence of a real problem. Similarly, advice to retain the child in a particular grade or to have the child tutored again doesn't really help. Recent research has shown that dyslexia won't go away, that a child is unlikely to outgrow it, and that extra emphasis on traditional teaching approaches will have little impact.

Fortunately, educators are becoming much more aware of the complexities of dyslexia. There has been greater emphasis on carefully selecting a teaching method rather than abandoning the child to a chance selection. And there is a growing trend toward prolonging remedial teaching programs so a child will have a better chance to learn to read, instead of cancelling instruction if improvement doesn't come quickly enough.

Some dyslexics are highly resistant to instruction, while others improve quickly and still others make steady

but very slow progress. Many have persistent spelling problems. Some acquire a basic reading skill, but cannot read fluently.

A number of factors seriously affect a child's ultimate ability to conquer dyslexia and achieve normal or near-normal reading skills. The most significant is an appropriate remedial program. But environmental and societal factors affecting the child may undermine the usefulness of any remedial program. The child's relationship with family, peers and instructors has been shown to have a major impact on the outcome of instruction. Is the family supportive? Do family members try to understand the child's difficulties, or do they merely brand the child as "dumb" or "lazy"? Are classmates sympathetic to the dyslexic's plight? In a supportive atmosphere, a child's chance of eventual success is much enhanced.

Often, qualities like "expectancy"—the degree to which a teacher expects a child to learn—have great impact. Usually, if learning is expected it will occur. Conversely, a child will not learn to read if the child is not given help and not thought capable of reading. And even slight progress in reading ability can make an enormous difference in academic success and vocational pursuits.

The age at which dyslexia is identified and remedial teaching begins also has a great bearing on outcome. The

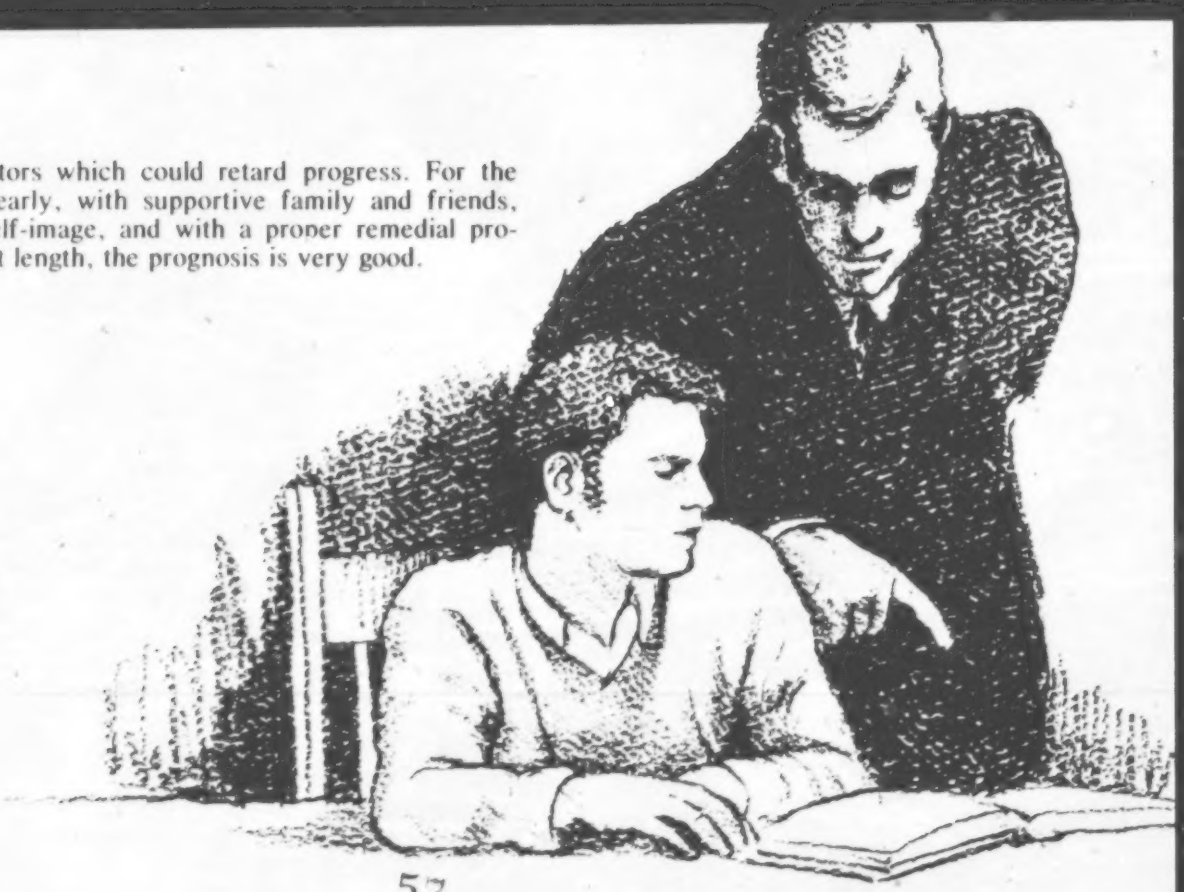
earlier the disability is discovered, the greater the percentage of children who achieve normal reading skills. Severe problems are more often ingrained by the time a child reaches the upper grades, making remediation more difficult. And older students are frequently less motivated because of repeated failure, making remediation even harder.

The length of remediation also affects a dyslexic's chances. Often, remedial programs are offered only in grade school, even though they may be needed through high school and college—especially if a dyslexic child is discovered late in elementary school. Remedial programs should be available as long as the student makes gains and is motivated to learn. Adults can make significant progress too, so there is no reason to shut out the older students.

The child's personality and level of motivation are important factors. Because the ability to read is vital to a child's healthy ego, dyslexia is detrimental to emotional adjustment. While dyslexics may have strong egos at first, repeated failure will inevitably take its toll, possibly causing serious personality problems. The child with dyslexia may react to repeated failure with anger, guilt, depression, resignation, and even total compromise of hope and ambition, and may need counseling to overcome these problems.

A dyslexic child will be able to make gains with outside help, but the assistance must be timely, thorough, and

aimed at all factors which could retard progress. For the child identified early, with supportive family and friends, with a strong self-image, and with a proper remedial program of sufficient length, the prognosis is very good.



Research Needs

Research in the reading field has been criticized because of its narrow scope and incompatibility with other research efforts. For far too long, dyslexia researchers have restricted their vision to too narrow a field and ignored the efforts of other professionals.

For the future, better coordination of efforts, better timing, and more use of research findings in medicine, psychology, education and linguistics will do much to improve our understanding of dyslexia.

To help establish a thorough understanding of dyslexia and reading disorders, additional basic research on the nature of the reading process should be conducted. With a better understanding of the normal reading process will come knowledge that can help improve regular classroom instruction, as well as diagnosis and remediation for the dyslexic.

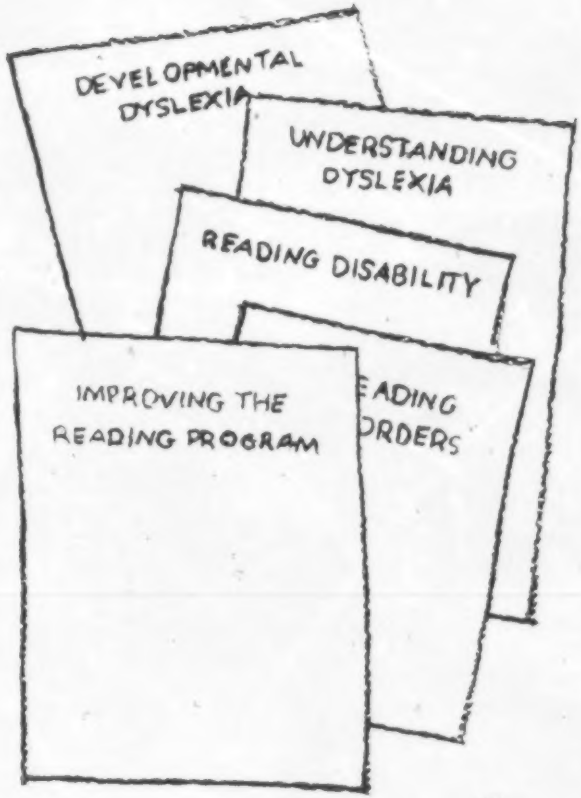
A comprehensive description of the heterogeneous dyslexic population would be of great benefit to future research. Results from many investigations are incomparable and difficult to interpret because of different terminology and conflicting descriptions. Many investigators still avoid the term dyslexia, while others use it incorrectly. By identifying and classifying the different categories of dyslexia, it may be possible to focus efforts on specific areas, rather than trying to study the whole field at once.

Failure to differentiate between dyslexia and reading problems associated with more general factors (such as lack of educational opportunity or retardation) is at least partly responsible for contradictory findings reported in the literature. A stricter classification of children with dyslexia as opposed to children with reading disorders and children deficient in other skills would help address the problem.

Children correctly identified as dyslexic should be followed more closely to see whether they improve as they grow older, and if so in what areas they improve. Educators still lack a method of distinguishing the dyslexic child from one who is slow or late in learning to read, but who will learn to read while still in the primary grades.

There has been some useful research on the etiology of dyslexia, but too often this information has been fragmentary and the findings not supported by other available evidence. More effort should be directed to establishing a complete picture of the relationship between causative factors and specific aspects of dyslexia. More research is needed on the relationship between dyslexia and childhood ailments known to affect the brain.

A closer comparison of American reading programs with those used in Europe may prove helpful. Why do Europeans teach their students the phonetics of their languages during the first few months of school, rather than



relying on the see-say method used in some American schools? And do European reading selections, often written by their best authors, affect the outcome of learning-to-read programs? The answers to these questions would clear up a great deal of controversy about dyslexia and teaching methods.

A culture-free intelligence test is needed. Such a test would help separate children who do poorly on the test due to dyslexia from other children who score low because of their cultural background.

Also needed is a valid, early detection system that could be used before the child begins formal reading—at a time when the central nervous system may be more responsive to change, and when the child has not yet suffered from the shattering effect of repeated academic failure.

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